P 001 248 US/HG

Optical communication system

Field of invention

The invention relates to optical communication systems. It has particular relevance to communication systems carrying WDM traffic channels.

Background art

Optical communication systems employing wavelength division mulitiplexing (WDM) use a single fibre to carry multiple traffic channels within a predetermined wavelength band. WDM systems are being deployed increasingly to optimise the transmission capacity of existing networks. Conventional WDM systems typically operate in a wavelength window centred around 1550nm. They also typically use at least one service channel for carrying system information, for example network control information and control signals. This channel is often carried on the same optical fibre as the traffic information, but outside the traffic carrying bandwidth. For example, a service channel commonly used with the 1550 waveband is carried on the 1510nm wavelength.

Many optical systems in use today operate in the 1300nm window. An example is the SONET/SDH. While WDM systems have obvious advantages, their introduction involves considerable investment as new equipment must be installed and maintained even in existing networks. The process is therefore a gradual one. When introducing WDM traffic to existing networks, operators are often obliged to maintain the previous service, at least for a time. The simultaneous operation of a WDM system operating in the 1550nm window with other services centred round the 1300nm waveband on the same network, and within the same nodes, requires certain measures to prevent interference between the two services. This includes the installation of filter components,

which may comprise simple fused couplers or thin film filters for separating the 1300nm waveband from the 1550nm waveband. In non-amplified WDM systems, filter components are necessary for separating out the service channel at each node. However, each filter component causes a basic power loss to channels passively relayed through the filter. The additional 1550nm/1300nm couplers along any single link will naturally increase the total link loss, in some cases to a level that exceeds the allowable link loss, such that the WDM system cannot be utilised over the whole network.

There is consequently a need for an arrangement that can allow WDM systems operating in a first wavelength band to be used on existing optical networks at the same time as optical systems operating in a second, different wavelength band.

SUMMARY OF INVENTION

The invention meets the above need by the provision of a node in an optical communications network that has a first set of add/drop filter elements for extracting and combining optical signals carried on wavelength division multiplexed channels in a first wavelength band and an extraction element and combining element for dropping and adding, respectively, a service channel associated with the wavelength division multiplexed channels. The extraction element is arranged upstream of the add/drop filter elements relative to the direction of traffic flow, and the combining element is arranged downstream of the add/drop filter elements. The extraction and combining elements are additionally adapted to drop and add, respectively, at least one further wavelength band carrying at least one optical traffic data channel.

By combining the adding and dropping of traffic channels that are separate from the WDM wavelengths with that of the service channel, the WDM traffic can be extracted, processed and combined with the transmission path in the

normal manner without the need for additional filter elements to prevent interference and without the additional imposed losses associated therewith.

The traffic channels carried on the second wavelength band are preferably not wavelength division multiplexed channels. However, this may not be the case, and the separation of the two bands prior to the dropping and adding of individual channels means that a second wavelength band carrying WDM traffic will likewise be protected from the additional loss of the WDM add/drop filter elements.

The extraction element is connected to a splitting arrangement for separating the service channel wavelength from the second wavelength band. The separated wavelengths can then be converted to electrical signals and processed separately. The second wavelength band and service channel wavelength are furthermore combined using a coupling arrangement which then relays the combined signals to the combining element.

Advantageously, a bypass path can be provided for the second wavelength band between the splitting arrangement and the coupling arrangement. The second wavelength band is thus merely removed from the transmission path to allow the WDM channels to be extracted from the transmission path, processed and added to the transmission path.

The second wavelength band is preferably arranged on the same side of the wavelength spectrum as the service channel wavelength relative to the first wavelength band, as this greatly simplifies the construction of the extraction and combining elements.

Preferably, the first wavelength band is centred around 1550nm, while the second wavelength band is centred around 1300nm. The service channel is

preferably carried at 1510nm.

The invention also resides in an optical network including nodes as described above.

BRIEF DESCRIPTION OF THE DRAWINGS

Further objects and advantages of the present invention will become apparent from the following description of the preferred embodiments that are given by way of example with reference to the accompanying drawings. In the figures:

Fig. 1 schematically illustrates an optical network,

Fig. 2 schematically illustrates part of a node in an optical communications network according to a first embodiment of the present invention, and

Fig. 3 schematically illustrates part of a node according to a second embodiment of the present invention.

DETAILED DESCRIPTION OF THE DRAWINGS

Fig. 1 shows an optical communications network comprising a number of nodes 10 connected by a bi-directional transmission path 20 constituted by optical fibres. In the simplified network shown in Fig. 1, the nodes 10 are connected to form a ring configuration, however it will be understood that the present invention may be employed in other network architectures.

Two communications systems are carried by the illustrated network. The first is a system carrying user traffic in the wavelength band centered around 1300nm, for example the SONET/SDH. The other system is a wavelength

division multiplexed (WDM) system operating in the 1550nm window. An optical service channel OSC carried at 1510nm provides system information, such as network monitoring and control information to and from each node 10 for the WDM system. Each node 10 comprises add/drop filter components for combining or extracting channels of specified wavelengths to and from the transmission path. Each wavelength that is not dropped by a filter component is passively relayed by the component, either by transmission or reflection, with a finite loss. The optical service channel OSC is also dropped at each node 10 that serves as a WDM node, i.e. a node that drops or adds WDM traffic.

Turning to Fig. 2, there is shown a schematic representation of part of a node 10 according to a first embodiment of the present invention. The figure specifically shows the arrangement of add/drop elements for a node wherein traffic channels carried in the 1300nm wavelength window denoted by B_{1300} and wavelength division multiplexed traffic channels carried in the 1550nm window denoted by B_{WDM} are added to the network and dropped from the network. Since the node 10 serves WDM traffic, the optical service channel carried at wavelength 1510nm and denoted by λ_{OSC} is likewise dropped and added at the node 10.

The data carried by wavelengths B_{1300}, B_{WDM} and λ_{OSC} arrives at the node 10 via the optical fibre transmission path 20. Only a single unidirectional fibre is shown in Fig. 2. It will be understood, however, that a second fibre may be provided for carrying information in the reverse direction. A first drop filter 100 is connected to the input fibre 20 for extracting the 1330nm wavelength window and the OSC channel. In the present embodiment, the OSC channel is carried at 1510nm. The OSC channel and the 1300nm traffic are thus carried on the same side of the wavelength spectrum relative to the WDM traffic and can be dropped from the transmission path 20 using filter having a simple

band pass or high-pass frequency transmittance characteristic. For a simple high-pass frequency characteristic, the cut-off frequency would be chosen to correspond to a suitable wavelength below, i.e. shorter than, the wavelength of the 1550nm window. Naturally, if the 1300nm or non-WDM traffic and the OSC channel were carried on wavelengths located on opposite sides of the 1550nm wavelength window, the drop filter 100 would be designed to have a high transmittance at the non-WDM traffic wavelengths and the OSC wavelength and a low transmittance in the 1550nm window. The filter 100 is preferably an interference filter, such as a thin film filter, but other filter designs are also possible, for instance a fibre grating filter such as a Bragg grating filter.

After extraction from the transmission path 20, the non-WDM channels carried on the wavelength band B_{1300} and the OSC channel at λ_{OSC} are fed to a further filter 110 which separates the wavelength band B_{1300} from the OSC channel wavelength λ_{OSC}. Filter 110 can be the same type as filter 100, i.e. preferably an interference filter. The non-WDM traffic is then processed in the usual manner by non-shown circuitry in the node 10. Information on the OSC channel is likewise received and processed by specific, non-shown circuitry as is generally known in the art.

The WDM channel wavelengths are passively relayed at filter 100 and undergo a finite power loss thereby. Depending on the filter technology utilised, the WDM channel wavelengths will be either reflected or transmitted by the filter 100. Additional add/drop filters 120, 130 are arranged on the transmission path for the WDM wavelengths, which for the sake of example will be denoted as λ_1, λ_1,... λ_n. These may take the form of multiple add/drop filters, where each filter is designed to drop and/or add a single channel wavelength λ_1, $\lambda_{2,...}$ λ_n, from among all the WDM channels. Alternatively, the filters 120, 130 may take the form of a demultiplexer and multiplexer,

respectively, for dropping/adding multiple channels $\lambda_1, \lambda_2, \ldots \lambda_n$ together and subsequently separating these into the individual wavelengths. It will be appreciated that any combination of wavelengths may be dropped and added by the elements 120 and 130 depending on the connections required in the network. The possible configurations are generally known in the art and will not be described further here.

Downstream of the final add filter 130 non-WDM traffic and the OSC channel are again added to the transmission path 20 using a coupler 140. The wavelengths of the non-WDM traffic B_{1300} and the OSC channel λ_{OSC} are combined upstream of this coupler 140 in a separate coupler 150. The couplers 140, 150 are preferably of the same type and design as filters 100 and 110, respectively, but may be of any suitable structure.

By dropping and adding both the non-WDM traffic and the OSC channel with the same add/drop filter the loss suffered by the WDM traffic channels is limited to that imposed by a single filter. This is of great advantage for non-amplified WDM systems, since each additional add/drop filter on the transmission path imposes a finite power loss on the channels. Each loss in power is equivalent to a specific length of optical fibre, so ultimately the number of add/drop elements on a transmission path limit the useful size of a network for WDM traffic. In conventional WDM systems the OSC channel is generally dropped for processing before the WDM traffic channels and recombined with the transmission path after any WDM channels have been added. Combining the extraction and addition of the non-WDM traffic channels with that of the OSC channel allows the network to be utilised simultaneously for different optical communication systems without imposing additional power loss on WDM channels.

In a further embodiment of the present invention the non-WDM traffic is not

processed at the node 10 but merely transmitted through the node. This is shown schematically in Fig. 3. The arrangement in Fig. 3 is almost identical to that of Fig. 2 with the exception that the non-WDM traffic at the 1300 wavelength band B_{1300} is not extracted for processing, but is instead transmitted directly to the coupler 150 for combining with the new information on the OSC channel λ_{OSC}. The non-WDM traffic is thus essentially bypassed. In addition to limiting the power loss imposed on the WDM channels, this arrangement also permits the standard WDM add/drop elements 120, 130 to be used. If the non-WDM traffic channels in the 1300nm wavelength band were transmitted through the node with the WDM channels, the filters 120, 130 would need to be specially adapted to prevent the two wavelength bands B_{1300} and B_{WDM} from interfering with one another.